STRATEGY RESEARCH PROJECT

TRANSFORMATION: TRANSITION FROM A HEAVY TO A LIGHTER FAMILY OF ARMORED FIGHTING VEHICLES

BY

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ABSTRACT

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Since the end of World War II, the single event with greatest impact on the development of armor was the war that did not happen–the expected conflict between the United States and the Soviet Union across the central front in Europe. This Cold War legacy meant the design of armor vehicles was driven by a competition that led to production of faster, more heavily armored, and more powerfully and accurately armed tanks. Since the end of the Cold War, the Army has responded to a number of crisis situations throughout the world. These responses are revealing that the Army's organizations and equipment platforms were not optimized for current missions. In October 1999, GEN Eric Shinseki, Army Chief of Staff, announced an Army transformation from a legacy force; to an interim force that serves as the Army's bridge to the future; and to an objective force that uses the best of science and technology to develop the Future Combat System.

Will transformation of the Army's armored forces into the objective force be evolutionary or revolutionary? Will the Interim Armored Vehicle (IAV) be available in sufficient quantities and types to impact the development doctrine, training and initial deployment of the Interim Brigade Combat Team (IBCT) in the schedule set by GEN Shinseki? Will technology be mature enough to support Engineering, Manufacturing and Development decisions for the FCS by FY 2006?

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One special person, my wife Sandi, wisely inspired me to stop researching and start writing; gave up part of Christmas vacation so I could finalize the first draft; and went through several "red pens" so I could ultimately finish this paper. Sandi is at the top of the list. I love you.

Finally, this paper is dedicated to all the soldiers of our armored force (past, present, and future). Their selfless service and dedication to freedom is a primary reason why we have the finest Army in the world.

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TRANSFORMATION: TRANSITION FROM A HEAVY TO A LIGHTER FAMILY OF ARMORED FIGHTING VEHICLES

> We have heavy forces that have no peer in the world, but they are challenged to deploy rapidly. The Army has the world's finest light infantry, but it lacks adequate lethality, survivability, and mobility once in theater in some scenarios. We must change.
>
> —General Shinseki

Since the end of World War II, the single event with the greatest impact on the development of armored vehicles has been the war that did not happen–the expected conflict between the United States (U.S.) and the Soviet Union across the central front in Germany.[1] This Cold War legacy meant that the design of armored vehicles was driven by a game of one-upsmanship during which tanks became faster, more heavily armored and armed with more lethal main guns.

Since the end of the Cold War, the threat of a confrontation with a major world power has significantly diminished. Consequently, the Army has reduced its forward presence and now projects power using a force primarily based in the U.S. This lack of forward presence means that we must move our forces over greater distances in order to respond with a full spectrum force to meet the requirements of our warfighting CINCs. To meet these requirements, the Army has responded to a number of crisis situations throughout the world in regions such as Southwest Asia, Africa, Central and South America and the Balkans.

Our armored forces were designed to meet the Cold War threat posed by the Soviet Union. However, due to the distances our forces must deploy and their mammoth size, it is difficult to transport and field these weapons in support of these Small Scale Contingencies (SSC). Further, once deployed, these heavy armored forces require extensive logistical support to remain active in these operations. It has become evident that the Army's organizations and equipment platforms are not optimally capable of limiting expansion of a crisis or stabilizing a conflict.

In October 1999, GEN Eric Shinseki, Army Chief of Staff, announced Army transformation. In his announcement, GEN Shinseki declared that the Army would seek to develop solutions which optimize smaller, lighter, more lethal, yet more reliable, fuel efficient, and more survivable forces. Army transformation currently includes a legacy force, which are

those current systems that will be modernized and recapitalized to provide strategic capability out to 2025. An interim force will serve as the Army's bridge to the future. The cornerstone of the interim force is the Interim Armored Vehicle (IAV). Finally, Army transformation will yield an objective force, which uses the best of science and technology to develop the Future Combat System (FCS). Figure 1 depicts GEN Shinseki's vision for Army transformation.

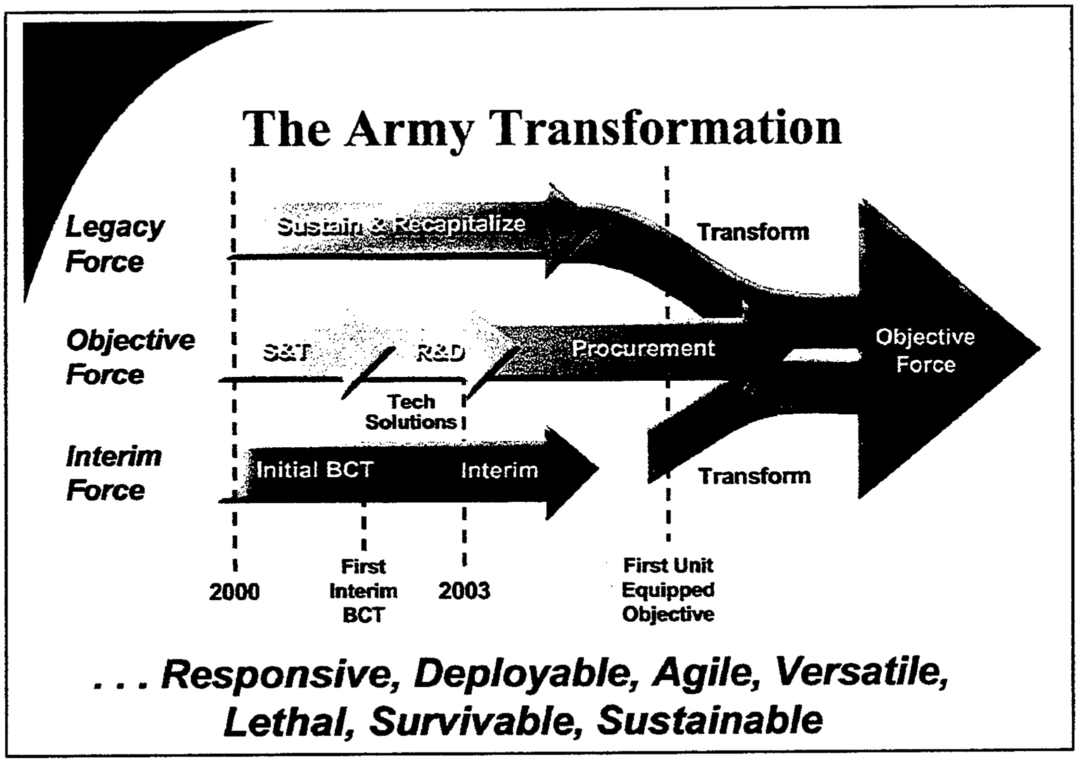

FIGURE 1. ARMY TRANSFORMATION

Will transformation of the Army's armored forces into the objective force be evolutionary or revolutionary? Will the IAV be available in sufficient quantities and types to support the development of doctrine, training, and ultimate deployment of the IBCT as scheduled by GEN Shinseki? Will technology be mature enough to support Engineering, Manufacturing and Development (EMD) decisions for the FCS by FY 2006? This study addresses these questions by reviewing tank development since World War II, analyzing the Army's efforts to transform its armored forces, and the concepts support development of the FCS. In addition, this study will propose capabilities the FCS should provide to the Joint Force Commander.

A HISTORICAL PERSPECTIVE – LEGACY ARMORED FORCE

Before we can look into the future, we must understand the past. Since the end of World War II, the single event with the greatest impact on the development of armored vehicle has been the war that did not happen–the expected conflict between the U.S. and the Soviet Union across the central front in Germany. Had this Super Power conflict erupted, it would have featured tank-heavy forces, mechanized infantry armed with handheld anti-tank guided missiles, tactical air support (aided by modern target acquisition systems), attack helicopters, and perhaps the use of nuclear, biological, and chemical (NBC) weapons.[2] This Cold War legacy makes it impossible to think of the tank as merely a single combat system. The tank is now viewed as an integral part of a combined arms system, which includes infantry, artillery, and aviation support designed to operate across a full spectrum of operations.

ARMOR DEVELOPMENT SINCE WORLD WAR II

Since the end of World War II, the design of armored vehicles has been driven by the Cold War. As one side would increase the survivability of its armor, the other side would counter with increased lethality of its main gun. This game of one-upsmanship led to faster, more heavily armored, and more powerfully and accurately armed tanks.

In early 1945, the Army Ground Forces (AGF) Equipment Review Board convened to consider the Army's postwar equipment requirements. In June 1945, the AGF Board recommended the development of three classes of tanks – light (25 tons), medium (45 tons), and heavy (75 tons). They also recommended an experimental 150-ton super-heavy class. In addition, the AGF Board recommended tanks with the following characteristics: main gun stabilization for both azimuth and elevation; radar range finder with the ability to identify friendly and enemy vehicles; an automatic loader; and special multi-fuel power plants developed specifically for armored vehicles.[3]

A few months after the AGF Board's recommendations, a more senior board was appointed to perform another review of post war equipment requirements. Although officially designated the War Department Equipment Review Board, it was referred to as the Stilwell Board (after its president GEN Joseph W. Stilwell). The Stilwell Board generally concurred with the recommendations of the AGF Board, but dropped the experimental 150-ton super-heavy class. As a result, the Army began development of the T37 light tank, the T42 medium tank, and the T43 heavy tank.[4] The Stilwell Board also recommended that weapons be specifically developed for tanks and armor be designed to defeat both shaped charge and kinetic energy

projectiles. Generally, post-war tank development followed the Stilwell Board recommendations.

Despite the Army's efforts to plan for the future, the end of World War II marked significant reductions in expenditures for military hardware (including armored vehicles) as the U.S. returned to a peacetime footing. For example, by April 1946 the Detroit Arsenal was closed and turned over to a small maintenance crew.[5] Between the end of 1945 to 1951, no new tanks were produced. The Army's standard tank at the end of World War II was the M26 Pershing, which was significantly under-powered and had the same engine as the M4 Sherman. A 500-horsepower engine was sufficient to power the 35-ton M4 Sherman, but struggled to serve the 45-ton Pershing. With 2,000 Pershings in the Army's tank inventory and no funding for a replacement tank, the Army undertook a modernization program including a new engine. The V-12 gasoline engine under development by Continental Motors Corporation offered the best solution to increase the Pershing's power. Following testing, this vehicle (with the V-12 gasoline engine) was standardized as the M46.[6] In 1949, Congress authorized an initial production run of 800 M46s, and the Army proposed converting an additional 1,215 M26s to the M46 in 1950.[7]

Events in Korea significantly changed the Army's tank development plans. The outbreak of hostilities in Korea caught the Army unprepared. The first tank force rushed to Korea was cobbled together from vehicles held in supply depots or assigned to infantry divisions stationed in Japan. U.S. involvement in the Korean War (coupled with a building fear of a Soviet threat in Europe) increased the demand for tanks. These demands far outstripped the number of M26s available for conversion to the M46, so only 319 of the new M46s became available for service.[8] The immediate need for additional tanks caused by the outbreak of the Korean War and the strategic situation in Europe did not allow the Army sufficient time to develop a new tank design.

Therefore, in September 1950 the Army decided to produce an interim tank by mounting the turret from the T42 on the hull and chassis of the M46, which was modified to provide increased armor protection. This resulted in the M47. The first pilot M47 was shipped to Aberdeen Proving Grounds (APG) for testing in March 1951, and production began at the Detroit Arsenal in June 1951, well before testing was completed.[9] Testing of the production vehicles began in August 1951 and ran for almost a year.[10]

This testing revealed a number of problems that had to be corrected before the M47 could be issued to field units. These problems included the complex and fragile nature of the range finder, the turret stabilization system, and the automatic loader, all of which ultimately were eliminated from final production. A total of 8,576 M47s were produced before production

ended in November 1953.[11] The M47 was intended as a stopgap measure. It was the last medium tank to retain the five-man crew with the hull machine gun reminiscent of World War II tanks.[12] Eventually, all but a few hundred M47s would be exported under the Military Assistance Program to provide the backbone of the NATO tank force for nearly 15 years.[13]

Design work on the replacement for the M47 began in late 1950. This new tank design, designated the T48, featured an elliptical hull and one-piece cast dome turret which provided improved armor protection. It also featured wider tracks, a fire control system incorporating a range finder, a ballistic computer and ballistic drive, a 90mm main gun that permitted 15-minute gun tube change, and a four-man crew.[14] The same 810 horsepower gasoline engine (AV-1790-5B) and cross-drive transmission (CD-850-4) used by the M47 powered this vehicle.[15] Chrysler Corporation was given a letter order to produce six pilot models and 542 production vehicles.

The Army planned to produce 9,000 M48s by mid-1954 to counter the imbalance between the Soviet and American tank forces. To meet this goal, production proceeded while testing and evaluation was ongoing. The first pilot M48 was completed one year after the initial letter order was issued, and the first production vehicle rolled off the line at Chrysler's new Newark, Delaware plant in March 1952.[16] The rush to produce the M48 resulted in significant operational readiness problems. These M48s suffered from engine, transmission, track, and suspension problems.

Between March 1952 and December 1954, approximately 7,000 M48s were produced, with an additional 2,500 completed by the end of 1956. Combat units started receiving the M48 in 1953, but correction of problems discovered after production delayed full fielding for some time.[17] The vehicles issued to combat units suffered from heavy oil consumption and engine failures after 1,000 miles. The gasoline engines consumed significant amounts of fuel, which limited their range to 75 miles. In addition, the M48s were too wide for many European tunnels, complicating rail transportation.[18] The operational readiness rates for these units were extremely low. These problems led the Army to establish integrating committees to coordinate tank and component development.[19] In addition, the Army also established special modification centers to correct design defects in the initial production vehicles.

Correction of mechanical and technical problems resulted in continuous improvement of the M48 series during the 1950s. In an attempt to increase the range of the M48, external fuel drums were added. These proved very unpopular with the units. Finally, modifications to the engine, by adding fuel injection, increased the range to 170 miles.[20] Lack of effective range would severely limit the M48 during its operational life. Production of the M48 ended in1959;

however, the Army concluded that it was technically feasible to upgrade some M48A1s with M60 series components, which included the AVDS-1790-2 diesel engine and CD-850-6 cross-drive transmission, aluminum fuel tanks, 105mm main gun, and the coincidence range finder, ballistic computer and articulating telescope. This combination of components significantly increased combat range and modernized the fighting capabilities of the M48. The resulting vehicle tests demonstrated that the upgraded vehicle compared favorably with the M60 and outperformed other M48 series tanks. In 1961, the Army ordered conversion of 600 M48A1s. However, these tanks were armed with the 90mm main gun because of the large stock of 90mm ammunition on-hand and because of a lack of funds to purchase sufficient quantities of 105mm ammunition to support conversion. These tanks were designated M48A3.

In the mid-1970s production delays in the M60A2 program and depletion of the M60A1 contingency stock inventory due to shipments to Israel in the wake of the 1973 war, meant the Army was unprepared to counter an increase of Soviet tank strength.[21] To meet this need for additional tanks, the Army decided to modernize its remaining M48 fleet to M60A1 standards. These modernized M48s were designated M48A5. The M48A5 program ran through 1979, with 2,069 being produced. A majority of these vehicles went to Army National Guard units. However, 140 M48A5s were sent to the 2nd Infantry Division in Korea to replace their aging M60A1 fleet.

In 1957, the Army reevaluated the direction that its tank development programs would take into the 1960s. Army Chief of Staff GEN Maxwell Taylor established the Ad Hoc Group on Armament for Future Tanks or Similar Combat Vehicles (ARCOVE). ARCOVE was tasked to study the tank armament requirements for the period after 1965, giving consideration to the effects of atomic weapons. ARCOVE recommended that maximum effort be given to equip tanks with guided missiles that used line-of-sight command guidance. To provide funding for this system, ARCOVE recommended that conventional weapons programs (such as hyper-velocity guns and penetrators) be sharply curtailed. ARCOVE also recommended further research on chemical energy warheads, target detection, armor and personnel protection.[22]

In August 1957, GEN Taylor approved many of ARCOVE's recommendations. He directed that tank design efforts focus on two vehicles: an armored airborne reconnaissance/assault vehicle (a light tank that would ultimately become the M551) and a universal main battle tank that merged the capabilities of the medium and heavy tanks. Both of these vehicles were to be equipped with guided missile systems.

Pending development of the new missile-firing main battle tank, which was expected to be the T95, the Army continued to produce the M48A2. In 1958, the Bureau of the Budget

(BoB) pressed the Army to speed up its tank modernization programs. BoB wanted the Army to pursue all means possible to replace its M48A2s and prohibited their further procurement after Fiscal Year (FY) 1959.[23] The BoB decision essentially killed further development of the T95 because of its cost and experimental status. To fill the void, the Army opted to build a new tank based on design concepts from the M48 program. This new tank would serve as an interim vehicle until the new missile firing main battle tank could be developed. This vehicle combined the M48A2 chassis, AVDS-1790 engine, and 105mm main gun. In March 1959 it was designated as the M60.

Combat units in Europe received the first M60s in December 1960, despite severe limitations on the availability of spare parts and ammunition.[24] A total of 2,205 M60s were built at Chrysler's Newark, Delaware, and Detroit Tank Plants. Further modifications improved the M60s performance. These included a longer turret to improve frontal protection and one more suited to the 105mm main gun, better suspension, redesigned commanders cupola, replacement of a steering wheel with T-bar, an electrical ballistic computer, and a coincidence range finder. These modifications resulted in the M60A1, whose production started in October 1962 and ended in 1980 after 7,948 had been produced.

During the early 1960s the Army decided to mount the newly developed Shillelagh missile system on the M60 chassis. This was the same missile system mounted on the M551. A new turret with smaller profile, better ballistic shape, and improved armor protection was developed for this vehicle. The Army considered this program to have a low-risk of failure because it mated two existing systems (M60 and Shillelagh missile) with a new turret.[25] Two pilot vehicles were delivered between November 1965 and February 1966. Vehicle testing revealed significant problems with both the Shillelagh system and the turret. These included problems with the combustible-cased ammunition for the 152mm gun-launcher, and when conventional ammunition was fired, the recoil of the main gun jarred the turret, throwing the fire control system off target. In 1966 and 1967, the Army placed orders for 540 of these vehicles, designated M60A2. However, due to the length of time required to resolve problems with the test vehicles, production did not start until 1973. The M60A2 did not reach combat units until 1974. Ultimately, six armored battalions in Europe were equipped with the M60A2. The M60A2 had low operational readiness rates due to the complexity of the gun/missile system. It was finally phased out of active service in 1982.

In 1969, the Senior Officers Materiel Review Board recommended an extensive product improvement program for the M60A1. These recommendations included improving reliability, mobility, night operability, and fire on the move capability. The Army implemented a majority of

these recommendations between 1971 and 1975. In 1978, the Army added a ruby laser range-finder and solid-state ballistic computer, along with a more reliable coaxial machine gun to the M60A1 and redesignated this vehicle as the M60A3.[26] These vehicles were provided to combat units in Europe starting in 1979. Shortly after production started, the passive night sight was replaced with a thermal sight, and a meteorological sensor was added. The M60A3 was the first tank outfitted with these systems, so it had a significant first-round hit advantage over any Soviet tanks at that time. This was proven under combat conditions in 1983 when Israeli's M60A3 successfully engaged the Syrian T72 (the standard Soviet tank). The M60A3 marked the end of the M60 series tanks. This interim tank served almost an entire generation of Army armor soldiers and leaders.[27]

Two factors guided the Army's program to develop a new main battle tank. The first was ARCOVE's recommendation that maximum effort be given to equip new tanks with guided missiles that used line-of-sight command guidance. The second was Secretary of Defense Robert McNamara's directive that the new main battle tank be a joint effort with Germany. Secretary McNamara felt the U.S. should work closely with Germany and the other NATO allies because only 5 percent of weapons were then jointly produced. This presented significant interoperatability challenges because the U.S., United Kingdom, and French all produced their own tanks. Only Germany used U.S. tanks, but they also wanted to develop their own equipment. Secretary McNamara hoped that other NATO nations would join this effort so NATO would field a tank jointly produced and shared by all their armies.[28] Agreement was reached with Germany in 1963 to jointly produce this new main battle tank. The objective of this agreement was to produce a main battle tank that incorporated the latest design concepts and that would be available for production by both countries by 1970.[29] This joint effort was designated the MBT70 and was specifically intended to operate in the combat environment in central Europe.[30]

Development of joint military characteristics for the MBT70 required resolution of several conflicting requirements. For example, Germany wanted a high-velocity gun, while the U.S. opted for a missile system. Also, Germany preferred the driver in the standard front hull position, while the U.S. team wanted the driver in the turret. Even though these conflicts were resolved, both countries continued to go their own ways on some components. For example, the Germans did not abandon their work on a 120mm cannon, and the U.S. continued work on a gas turbine engine.

Lockheed Missile and Space Company won a contract to perform a parametric design/cost effectiveness analysis on the design concepts. This analysis recommended five

candidate vehicles for further study. A full-scale mock-up was made for each candidate vehicle. These vehicles underwent further study, from which two vehicle designs were given final consideration. The final selection contained features from both candidates.

Initially, eight pilot tanks were to be produced for each country. The first pilot vehicle was completed in the U.S. in July 1967. It was displayed simultaneously with the German prototype in September 1967.[31] These were automotive pilots and were not fitted with armament or fire control systems. This new main battle tank featured, for the first time, a crew of three. This was accomplished by incorporating an automatic loader, another first for a U.S. tank. The entire crew was located in the turret, with the driver in a counter-rotating capsule.[32]

The MTB70 was armed with a 152mm gun-launcher. This was the long-barreled version of the gun-launcher used in the M60A2 and the M551. It fired the Shillelagh missile and all the conventional ammunition available for the short-barreled version. It had a secondary armament of a remote controlled 20mm automatic cannon, which retracted under armored covers when not in use. The MBT70 featured a sophisticated fire control system which included a laser range-finder, a ballistic computer with digital analyzer, sensors to signal powder temperature, gun deflection due to temperature changes and ambient air data, and night-vision sights. The MTB70 also featured a hydropneumatic suspension system that could raise, lower, or tilt the tank in any direction.[33]

The first full pilot arrived at Aberdeen Proving Grounds (APG) for testing in late 1969. As anticipated, significant developmental problems surfaced in the complex systems in the MBT70. These problems and their ultimate changes resulted in further delays and increased costs. Congress criticized the MBT70 program as being too complex because it used risky technology. In addition, Congress was very concerned about increased program costs. The initial cost for developing the MBT70 was $80 million. However, by late 1969, the estimated cost for development and production had climbed to $544 million, and each vehicle would cost $1.2 million.[34] Also in 1969, David Packard became Deputy Secretary of Defense. Based on his strong business background, he was charged with increasing efficiency and saving money in DoD. After reviewing the MBT70 program, he became convinced that further development of a joint tank was not warranted. In early 1970, after several months of negotiations, Germany and the U.S. agreed to terminate their joint venture and cooperate closely as each developed their own tank.[35]

Following termination of the joint program, the Army initiated efforts to develop the second-generation main battle tank following the general design configuration of the MBT70. This vehicle was simplified to improve reliability and reduce cost.[36] All German components

were replaced with those made in the U.S., and it retained the 152mm gun-launcher. This vehicle was designated the XM803. Two of these vehicles were authorized for construction; however, only one was completed. The XM803 was simplified from the MBT70, but it did have such innovative features as spaced armor, self-sealing fuel tanks, and blow-off vents for ammunition storage. However, cost was still a significant problem. In addition, problems with the 152mm gun-launcher system encountered during operations of the M551 and M60A2 resulted in a loss of favor for a combination gun-missile system.[37] As a result, in late 1971 Congress cancelled funding for the XM803 and directed the Army to initiate development of a less costly main battle tank.

Cancellation of the MBT70/XM803 programs closed a ten-year period during which no new U.S. tanks were produced to counter the threat posed by the next generation of Soviet tanks. The design of the MBT70 outpaced the technical capabilities of the 1960s. However, many of the components from the MBT70/XM803 would ultimately be incorporated into the M1 series design.

Although Congress cancelled the XM803 program, it authorized the Army $20 million to procure prototypes of two new main battle tank designs for test and evaluation. Congress provided these funds because the Soviets were continuing to build large numbers of tanks and improving their capabilities, which threatened to outpace the capabilities of the M60. In addition, costs of the Vietnam War had virtually stalled heavy force modernization programs, allowing the Soviets to increase their lead further.[38]

In January 1972, the Main Battle Tank Task Force was established to develop the basic characteristics for the new tank. In March 1972, the Army Chief of Staff directed that this new main battle tank be fielded within six years, which was significantly shorter than the normal ten-year development period.[39] The following table specifies the Task Force's key characteristics:

Weight	46-52 tons combat loaded
Operating radius	275-325 miles
Survivability	armor protection against the Soviet 115-mm gun, internal compartmentalization, external fuel stowage, interior spall liner
Armament	105-mm or 120-mm main gun; 1x .50 caliber MG; coaxial 25-mm Bushmaster cannon; turret mounted 40-mm grenade launcher
First round hit probability (service test with kinetic energy round at 1500 meters range)	Stationary vehicle vs stationary target: 92% Moving vehicle vs. moving target: 58%
Road speed	25 miles per hour
Dash speed	40-50 miles per hour
Mobility	35% of operation off roads

TABLE 1. DESIRED CHARACTERISTICS FOR A NEW MAIN BATTLE TANK[40]

These characteristics reflected the Task Force's analysis of current available tank capabilities and known threats. In addition, the Task Force sought to provide a low-cost solution that could accommodate technological improvements as they became available.[41] Selecting a conventional gun as the main armament reversed the trend established by the recommendations of ARCOVE in 1957.

During the 1973 Yom Kipper War, hollow-charged rocket-propelled grenades and anti-tank guided missiles defeated a significant amount of Israeli armor. Citing an analysis of the results of this war, the Army placed crew survivability at the top of its priority list for the new main battle tank. As a result, the design of the XM1 included lower vehicle profile, armored bulkheads between the crew and fuel cells, ammunition storage behind armored doors, blow-off panels in the turret roof to vent explosions up and away from the crew and a spall liner and Halon fire extinguisher system. In addition, GEN Creighton Abrams, the Army Chief of Staff, decided to increase the XM1s weight to 58 tons, to include a new composite armor developed by the British. This Chobham armor contained a combination of various materials designed to defeat hollow-charged weapons.

The XM1's fire control system benefited from developmental work on the MBT70/XM803 and M60A3 programs. It included an analog computer, stabilization, thermal sights, a laser range-finder, and sensors for environmental inputs. The system also featured a muzzle reference sensor to detect gun tube droop. The XM1 was armed with the same 105mm gun as the M60A3.

In 1973, the Army launched the first phase of the XM1 program validation competition between two contractors–Chrysler and General Motors. This phase required each contractor to deliver a prototype tank, automotive test vehicle, and ballistic hull and turret to APG for testing.[42] The completed validation prototypes were delivered to APG and were tested from January–May 1976. During this same period, the automotive test vehicles underwent driving tests of more than 3,000 miles. Both contractor's vehicles performed well, but the Chrysler vehicle, powered by a gas turbine engine, showed slightly greater acceleration.[43] All testing of the prototypes was completed in July 1976; however, the winner of the competition was not announced until November 1976. This delay allowed both contractors to refine their designs and better determine their manufacturing costs.[44]

Chrysler was awarded a 36-month contract for full-scale engineering development of 11 pilot tanks. All of the pilot vehicles were delivered during 1977. The development phase ran from February 1978 to September 1979. From April 1978 to February 1979 soldiers from the 2nd Squadron, 3rd Armored Cavalry Regiment, manned test vehicles. Results from these tests

were generally poor. Engines failed because dust clogged air filters; and track was easily thrown due to buildup of soil between the sprocket hub and sponson. These technical problems were solved and further tests at Fort Knox went well. In addition, survivability tests were conducted at APG. During these tests various types of ammunition were fired at the test vehicle. Upon completion of these tests, the vehicle was driven off under its own power.

In May 1979, the XM1 was approved for low-rate production, and Chrysler received a contract to build 110 more vehicles for extensive field testing in various weather, topographical, and radioactive environments. These tests went well, with the exception of continued reliability problems with the gas turbine engine. This vehicle was standardized as the M1 in 1981, with production approved for 7,058 tanks. The first M1s were provided to combat units in Europe in late 1982 and fielding continued throughout the 1980s.

As mentioned earlier, the M1 was designed to accommodate upgrades as new technology became available. The first upgrade included increased frontal armor, more external stowage and suspension improvements. The upgrades yielded the Improved Performance (IP) M1. In 1985, the first M1A1s were delivered to the Army. The M1A1 featured a 120mm smooth bore main gun, a microclimate crew cooling system, and NBC overpressure system. By 1989, all armor units in Europe were equipped with the M1A1.[45] The addition of depleted uranium armor mesh resulted on the M1A1 Heavy Armor (HA). However, not all M1A1s were provided this additional armor protection. The M1A1 production run ended with 2,329 M1A1s and 2,140 M1A1(HA) being produced.[46]

The Gulf War occasioned the use of the M1A1 in combat, demonstrating its value in combat situations. While M1A1s suffered from some mechanical problems due to desert conditions, they consistently maintained operational readiness rates of over ninety percent. In addition, the thermal sights allowed engagement of targets at night, in sandstorms, and in smoke. First round kills at ranges from 2,000 to 3,000 meters and in some instances through berms built to protect enemy vehicles were documented.

The first set of upgrades resulted in the M1(IP), M1A1, and M1A1(HA). The second upgrade package included improvements in the vehicle's electronic systems. The M1A2 incorporated digital technology to improve navigation, tactical operations, and fire control. In addition, this technology has the capability to ran a continuous series of diagnostic tests to determine mechanical and electronic failures. The M1A2 retains the 120mm gun and incorporates a Commanders Independent Thermal Viewer that allows the commander to select one target and the gunner to select a different target. This capability was originally developed for the MBT70, but eliminated in the M1 for cost reasons.[47]

The Army received the first prototype M1A2 in 1990. Initial operational tests showed only marginal improvements over the M1A1. Given the drawdown of the Army after the Gulf War, the M1A2 was almost scrapped. However, sales to foreign countries kept the production of M1A2s open until 1993. The Army only received a few prototypes and sixty-two new M1A2s. The rest of the M1A2 fleet is now being produced through conversion of M1s. The first M1A2s were provided to the 3rd Battalion, 8th Cavalry in 1995. The remainder of the 1st Cavalry Division started receiving the M1A2s in 1996.

In 1994, the Army decided to upgrade the M1A2 with a System Enhancement Package (SEP). The M1A2 SEP features a second-generation Forward-Looking Infrared Radar gunner's primary sight and commander's independent thermal viewer, Force XXI Battle Command for Brigade and Below system ($FBCB^2$), a thermal management system, and the latest armor package. The M1A2 SEP entered production in 1999 at the rate of 120 vehicles per year. Although the M1A2 SEP will be the most modern heavy vehicle in the armored force until 2011 or later, budget restrictions have limited its production to 1,150 vehicles. To better provide a force that can respond across the full spectrum of operations, the Army is currently undergoing a transformation of its armored force.

NEED FOR CHANGE – INTERIM ARMORED VEHICLE (IAV)

Since the end of the Cold War, the Army has responded to a number of crisis situations in regions such as Southwest Asia, Africa, Central and South America, and the Balkans. To meet these challenges, the Army responded with a full spectrum of forces. However, in responding to these situations, it has become apparent that the Army's organizations and equipment platforms are not responding optimally to limit expansion of a crisis or to stabilize a conflict.

The Army's heavy forces were designed to gain and hold ground through the use of their direct fire capabilities in an Major Theater War (MTW). Now these heavy forces are challenged to rapidly get to and operate in SSCs. Further, once deployed, these heavy forces require a significant logistical effort to sustain their operations. The Army's light forces can rapidly deploy anywhere in the world, but they have insufficient staying power, lethality, and mobility once inserted. In addition, the Army's logistical footprint for deployed forces is extremely large because of significant demands and a complex inventory of multiple types of equipment. So large inventory stockage levels are needed for numerous lines of repair parts. These conditions were evident during Army operations in Desert Storm, Somalia, Bosnia and Kosovo. They

hinder the Army's ability to provide a full spectrum of responses to meet the requirements of the warfighting CINCs.

In October 1999, GEN Eric Shinseki, Army Chief of Staff announced an Army transformation. In his announcement, GEN Shinseki stated that:

> We will begin immediately to turn the entire Army into a full spectrum force which is strategically responsive and dominant at every point on the spectrum of operations. We will jump-start this process by investing in today's "off-the-shelf" equipment to stimulate the development of doctrine, organizational design, and leader training even as we begin a search for new technologies for the objective force.[48] Further, he stated that when technology permits, we will erase the distinction, which exists today, between heavy and light forces ...[49]

GEN Shinseki's transformation effort seeks to significantly improve the Army's strategic responsiveness by providing a combat-ready brigade anywhere in the world in 96 hours, a division on the ground within 120 hours, and five divisions in 30 days.

INTERIM ARMORED VEHICLE

The cornerstone of the Army's near term transformation effort is the acquisition of an "off-the-shelf" IAV. In December 1999 and January 2000, the Army invited various armored fighting vehicle manufacturers to Fort Knox to demonstrate their equipment. The Army reviewed both tracked and wheeled armored fighting vehicles during these demonstrations. Following these demonstrations, in April 2000, the Army issued a request for proposal (RFP) for its IAV. Competitors were advised that their proposals must address the following performance characteristics:[50]

- Interoperability – IAV must be capable of hosting and effectively integrating existing and planned Army Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems.
- Deployability – IAV must be transportable in a C-130 aircraft with a combat capable deployment weight not to exceed 38,000 pounds gross vehicle weight (19 tons).
- Mobility – IAV must be capable of sustained hard surfaced speed of 40 miles per hour; maintain cross-country mobility as outlined in the Operations Mode Summary/Mission Profile; provide cruising range of at least 300 miles without refueling; climb 18 inch vertical obstacles; climb and descend hard surface 60 percent frontal slopes and negotiate a hard surface 30 percent side slope; ford one meter water depth; and move 50 meters from a standing start in less than eight seconds.

- Survivability – IAV must provide integral protection from 7.62mm Armor Piercing (AP) rounds; provide scalable add-on armor capable of defeating 14.5mm AP or hand-held HEAT round up to RPG 7; provide overhead protection against 152mm high explosive air burst; full crew protection from blast and overpressure from anti-personnel mines; integrated NBC sensor suite; and crew compartment provided with spall lining.
- Sustainability – IAV capable of rapid refueling in four minutes or less; and provide an auxiliary power source to power critical systems for at least 12 hours.
- Lethality – (Infantry Carrier Vehicle) armament capable of day and night operation with a range of 1500 meters.

The Army issued 200 RFPs to interested parties and received 20 proposals. After reviewing each proposal and conducting an evaluation of sample IAVs at APG, the Army chose the Light Armored Vehicle 3 (LAV 3) built by General Dynamics Land Systems/ General Motors – Canada (GDLS/GM). The LAV 3 was selected over other competitors (wheeled and tracked) because it surpassed the Army's requirements for speed, mobility, and armor protection. In addition, the LAV 3 meets the goal of reducing the Army's logistic footprint by using the same repair parts and engine as the Family of Medium Tactical Vehicles.[51] However, the LAV 3, may provide insufficient survivability if it encounters large-caliber tank main gun weapons and anti-tank guided missiles.

During the next six years, the Army plans to purchase up to 2,131 LAV 3s at a total cost of $4 billion.[52] In addition to the Infantry Carrier, the LAV 3 will provide the basic platform for a number of variants – including a mortar carrier, anti-tank guided missile carrier, reconnaissance vehicle, fire support vehicle, engineer support vehicle, commander's vehicle, medical evacuation vehicle, NBC reconnaissance vehicle, and mobile gun system.

The Army originally planned to equip the Interim Brigade Combat Teams (IBCT) with the LAV 3 family of vehicles by 31 December 2001. However, delays in selecting a contractor coupled with the contractor's inability to meet delivery schedules have resulted in slippage of time lines, moving equipping the first IBCT until 31 March 2003. The date may further slip for two reasons:

- United Defense L.P., an unsuccessful contractor in the competition to supply the IAV has filed a contract protest with the General Accounting Office (GAO). United Defense's protest is based on their ability to meet the Army's delivery time lines and the lower cost/value factors in their proposal. The GAO has 100 days to review the issues raised by United Defense and make recommendations to the Army.

However, adjudication of contract protests typically adds at least six months to any established delivery times.

- The FY 2001 Defense Authorization Act required a side-by-side testing program be undertaken to test the LAV 3 against the troop-carrying medium armored vehicles currently in the Army inventory. The M113A3 Armored Personnel Carrier equipped with Force XXI Battle Command for Brigade and Below ($FBCB^2$) system will be used for comparison with the LAV 3. The purpose of this testing program is to prove that acquisition of the LAV 3 is a sound investment compared to the Army's inventory of Vietnam era tracked vehicles.[53] The schedule for this testing program is pending the resolution of the contract protest.

Additionally, equipping the first Interim Brigade Combat Teams (IBCT) with all 10 variants of the LAV 3 will be significantly difficult because the Mobile Gun System, Fire Support Vehicle and Nuclear, Biological, and Chemical (NBC) vehicles are still in the development phase. Currently, the Army anticipates these vehicles to be initially fielded in the FY 2004 to FY 2006 time frame. It will be very difficult for the IBCT to be fully mission-capable with three of its vehicle types being unavailable until the FY 2004 to FY 2006 time frame.

INTERIM BRIGADE COMBAT TEAM

Concurrent with the acquisition of the LAV 3, the Army is transforming two brigades stationed at Fort Lewis into IBCT, in a two-phased process. During Phase One, the brigades cross-attach battalions, turn in equipment, reorganize and begin dismounted training. Mounted training for the first IBCT is being conducted with vehicles on loan from several sources including several foreign countries. During Phase Two, the brigades receive and train in the IAV and conduct a training certification event.[54] The 3rd Brigade, 2nd Infantry Division, was designated as the first IBCT. It began reorganization, turning in equipment and training starting in April 2000. It was projected to be trained and ready for employment by 31 December 2001. However, we have noted, this date has slipped at least 16 additional months, and perhaps as much as two years.

Fully equipped, the IBCT is designed as a full-spectrum early-entry combat force. It will have the capability to operate in all operational environments and against all projected future threats. However, the IBCT is primarily designed for employment in SSC in complex and urban terrain to confront low-end and mid-range threats that may employ both conventional and asymmetrical capabilities.[55] The IBCT can participate in a MTW as a maneuver element within a division or corps with heavy armor augmentation. In addition, IBCT can participate in military

operations other than war as an initial entry force or guarantor force to provide security for stabilization operations.[56] The IBCT will be capable of conducting all major doctrinal operations: offense, defense, stability, and support.[57]

The IBCT brings to the fight the following operational characteristics:[58]

- Dismounted assault and the close fight – The IBCT achieves tactical superiority through combined arms action at the company level. These actions feature dismounted assault supported by direct fires from organic IAV platforms and the integration of mortar, artillery, mobility support, and joint fires.
- Enhanced situational understanding – Situational understanding is the fundamental force enabler across all IBCT battlefield operating systems and the foundation for risk mitigation with respect to its vulnerabilities, particularly the lack of substantial armor protection. The IBCT will employ an integrated suite of intelligence, reconnaissance and surveillance capabilities and digitized battle command systems to develop and disseminate a common operational picture.
- Lethality – The IBCT will possess an array of direct and indirect fire systems to shape the battlespace. These include mobile gun system; TOW 2B anti-tank guided missiles; Javelin anti-tank missiles; 120mm, 81mm and 60mm mortars; and 155mm artillery.
- Holistic force protection and survivability – The IBCT will meet force protection challenges through the application of a variety of capabilities - including early warning, situational understanding, avoidance of surprise, deception, rapid mobility, signature control, nontemplatable operations, avoidance of enemy fires, mutual support, use of cover and concealment, and implementation of innovative tactics, techniques and procedures.
- Force effectiveness – The IBCT will offset the limitations of its IAV platforms through the integration of is capabilities, particularly the internetted actions of the company combined arms teams.
- Reachback – The effectiveness of the IBCT is enhanced by its capability to reach back for non-organic supporting resources. The IBCT executes reachback in five primary areas: fires and effects, intelligence and information, planning and analysis, force protection, and sustainment.

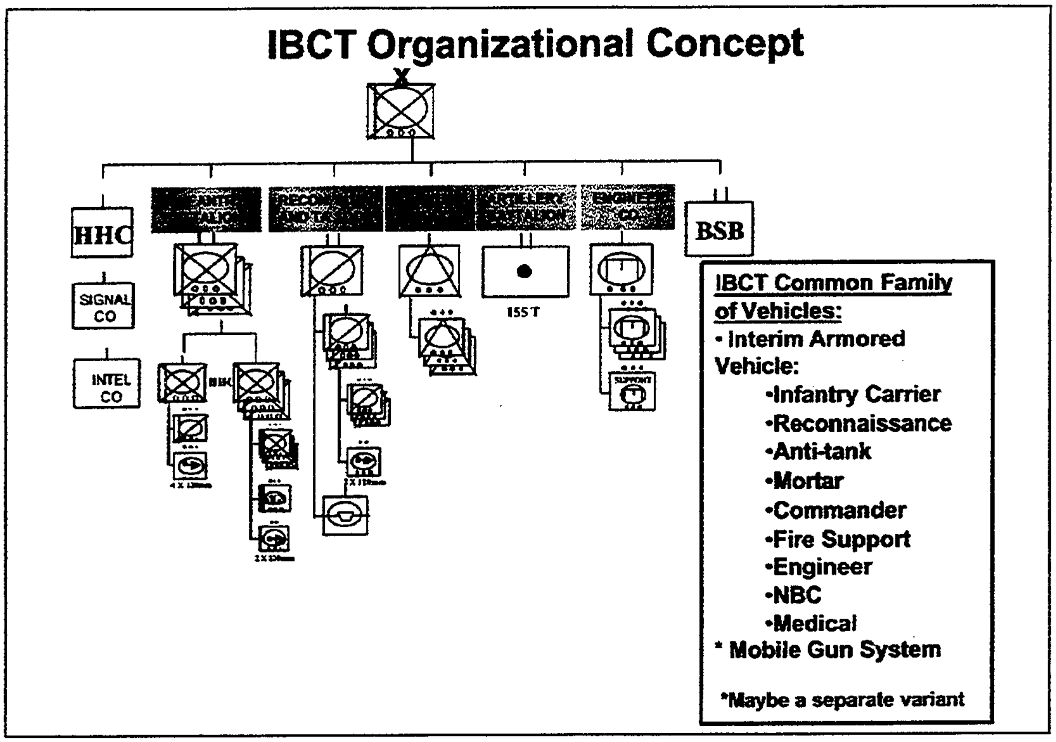

FIGURE 2. IBCT ORGANIZATIONAL CONCEPT

The IBCT is a combined arms organization, organized as follows:

- Three infantry battalions
- Reconnaissance, surveillance and target acquisition squadron
- Anti-tank company
- Field artillery battalion
- Engineer company
- Signal company
- Military intelligence company
- Brigade support battalion

As the interim force, the IBCT will test doctrine, organization, and training systems to serve as a bridge to the future Army (the objective force). Upon certification, the IBCT will be capable of executing missions in support of the National Military Strategy (NMS). However, the IBCT will not be capable of accomplishing the full spectrum of operations as envisioned until it receives a full complement of IAVs.

What happens to the current armored force and the Abrams and Bradley during transformation? As part of the transformation plan, the Army will maintain essential legacy warfighting capabilities to execute the NMS. This capability is called the Counter Attack Corps,

which will consist of three heavy Divisions and one Armored Cavalry Regiment. This force will support the two MTW strategy of the NMS. III Corps (with its two heavy divisions) and the 3rd Infantry Division will make up the bulk of the Counter Attack Corps.[59]

Current plans call for the modernization and recapitalization of the Abrams main battle tanks and Bradley fighting vehicles assigned to these units. Modernization requires developing and/or procuring new systems with improved warfighting capabilities. Recapitalization is accomplished by rebuilding and selectively upgrading current fielded systems to ensure operational readiness and a zero time/zero mile maintenance standard.

For example, the Army recently started fielding the M1A2 SEP and will continue this effort until 2011 or later.[60] The M1A2 SEP features a second-generation Forward Looking Infrared Radar gunner's primary sight and commander's independent thermal viewer, Force XXI Battle Command for Brigade and Below (FBCB^2) system, a thermal management system, and the latest armor package. In addition, the Army is rebuilding some M1A1s and conducting selective upgrades, such as replacing analog with digital systems, adding FBCB^2, and providing far-target locating capabilities.[61]

Since initial fielding of the Abrams in the early 1980's, the Army has not improved the engine. The last new engine was produced in 1993; since then, the program has focused on rebuilding existing engines.[62] Each time an engine is rebuilt, it loses some capability. To address this problem, the Army recently awarded a contract to Honeywell/General Electric to produce the LV100 turbine engine, which offers 30 percent lower fuel consumption, 43 percent fewer parts, and 100 kg less weight.[63]

The Army is also improving the ammunition used by the Abrams to increase lethality and extend the close fight. Some of the proposed ammunition improvements include a 120mm canister round to provide rapid area suppression; an improved 120mm sabot round that can defeat any modern armor that may come onto the scene over the next ten years; and a 120mm Tank Extended Range Munition that has the capability of shooting direct line-of-sight or beyond line-of-sight up to 10 kilometers, giving the Abrams significantly greater stand-off capability.

Army leadership decided not to incrementally improve the M1 series into a future main battle tank. Instead, the Army opted to focus its research and development resources on a completely new platform called the Future Combat System (FCS).

A LOOK INTO THE FUTURE – FUTURE COMBAT SYSTEM

In 1995, leadership within the Army's armor community developed an initial set of operational characteristics for the FCS, including the ability to destroy multiple targets at five

kilometers and beyond; a cross-country dash speed of one hundred kilometers per hour; a digital communications system; capability for continuous operations in all battlefield environments; a logistics tail of half that currently required for the M1 series tanks; and ease of air transportability. The FCS would rely less on armor protection and more on active systems that detect and destroy incoming projectiles before they hit the vehicle.[64]

In 1996, an integrated concept team was formed at the Armor Center. This team examined available technologies and possible alternatives for the FCS. To meet the Army's need for deployability and great mobility, the weight of the FCS was decreased from 40 tons to the 20-ton range. By 1998, the Armor Center's work on the FCS prompted the U.S. Army Training and Doctrine Command (TRADOC) to create an overarching Future Combat Vehicle effort. TRADOC focused their efforts on the FCS, along with modernization of the industrial base, future force structure and design, and development of doctrine based on an analysis of potential threats.

Accordingly, TRADOC developed a Mission Needs Statement (MNS) for the FCS. This MNS analyzes future threats out 25 years and describes the capabilities FCS must provide the Joint Force Commander. A summary of capability requirements for the FCS follows:[65]

- The FCS equipped force must provide increased capability for strategic responsiveness; operational maneuver; and tactical flexibility for mounted operations by conducting and supporting direct close combat, delivering precise line-of-sight and non-line-of sight munitions, performing and supporting reconnaissance, surveillance, and target acquisition, and tactically transporting infantry, combat engineers, and materiel.
- The FCS force will be structured to exploit information dominance through a collection of fighting ensembles.
- The FCS force will be equipped with a seamless tactical network of information within and between units, between leaders and soldiers within the unit, and between individual platforms and individual sensors.
- The FCS force must be able to achieve combat overmatch by seeing the enemy first, responding first, and destroying or neutralizing any target or command using a broad range of lethal and non-lethal options.
- The FCS equipped force must be capable of surviving first-round engagements from future armored platforms, anti-armor systems, shoulder-fired antitank systems, direct energy weapons, rockets, artillery and mortar munitions, and mines.

- The FCS force should be capable of traversing all anticipated land environments, open, restricted and complex terrain without compromising tactical unit integrity.
- The FCS platforms must be smaller and lighter, compared to current platforms. They must be transportable in unit sets on C-130 like platforms, including the Future Transport Rotorcraft.[66]
- The FCS force must be capable of operating at a high operational tempo for at least three days and at a medium operational tempo for at least seven days without maintaining, rearming, or resupply.
- The FCS must deliver rested, situationally aware, fully charged, and equipped soldiers to the required point on the battlefield.
- The FCS units must include internetted embedded training without increasing the training burden on Army institutions or operators.

On 1 June 1999, the Army and the Defense Advanced Research Projects Agency (DARPA) entered into a collaborative effort to develop the FCS. The objective of the FCS Program was to develop a lightweight, overwhelmingly lethal, strategically deployable, self-sustaining and survivable combat and combat support force, systems and supporting technologies for the 2012-2025 timeframe and beyond.[67] This program was envisioned to be a significant departure from the Army's past armor modernization programs, which focused on a series of incremental product improvements. The FCS program is designed to achieve a leap-ahead in operational capabilities and significant reductions in supportability requirements through the use of innovative technologies. This is a high-risk venture because many of these technologies must mature before they are usable in a production FCS. The FCS program philosophy is based on the competition of ideas between capabilities derived from combined changes in operational concepts and technological solutions that are or will be available in the near future.[68]

In January 2000, DARPA, on behalf of the Army, issued a solicitation for the development of design concepts for the FCS. In May 2000, DARPA awarded contracts, worth $10 million each, to four contractor teams. Within 24 months, these contractor teams are to:

- Develop the FCS design concept and its associated concept of operations.
- Provide a preliminary design to support a decision to proceed to critical design review and development of Program Objective Memorandum funding for engineering, manufacturing and development by FY 2006.
- Fabricate and test a FCS demonstrator.
- Develop innovative enabling technologies for insertion into the demonstrator.

The Army and DARPA have programmed $916 million over six years (FY 2000 to FY 2005) for development of the FCS program.[69]

A CONCEPTUAL VIEW OF THE FCS

The Army does not know what design concepts the contractors will propose or what the FCS will ultimately look like. However, we can use our imagination to develop our own conceptual view of the FCS. My conceptual view of the major capabilities a FCS might bring to the battlefield of the future is stated below. These concepts are public knowledge. Many were discussed in a series of articles on the FCS and the Future Scout and Cavalry System by Dr. Asher H. Sharoni and Lawrence D. Bacon. These articles appeared in Armor magazine from 1997 to 1999.

Lethality

- **Primary Armament System:** The FCS will be armed with an electromagnetic (EM) gun. The EM gun utilizes pulse electrical energy to launch a light projectile (30-60mm) at hypervelocities between 4,000/8,000 meters per second. The EM pulse travels at near the speed of light (186,000 miles per second) so it is inherently immune to natural limits of gas expansion.[70] The gun consists of two or more highly conductive rails with the projectile positioned between them and enclosed in a leading bore. As high current is supplied to the rails, the arc creates a strong magnetic field across the rails, which accelerates the projectile down the barrel.[71] Several technological issues must be resolved before the EM gun is practical. However, the scientific community is working on fixes to resolve these issues so EM gun technology is the preferred future choice.
- **Secondary armament systems:** The FCS will be equipped with a high-energy laser gun for use against close-in targets such as helicopters, soft skin vehicles, and infantry. The FCS will also be equipped with dual-purpose fire-and-forget anti-air/anti-armor missiles. These missiles will provide beyond-line-of-sight capabilities to ranges as much as 50 kilometers.

Battle Management System: The FCS will be equipped with a peripheral, multi-sensor-aided target acquisition and fire control system. This system will have day/night capability to automatically engage and provide management of up to 10 to 20 active and passive targets simultaneously and autonomously. Automatic air/ground target acquisition will be achieved through thermal imagery, millimeter-wave radar, and direct optical sights. This system will offer full fire-on-the-move capability for engaging multiple targets.[72]

Survivability: The FCS hull/turret will be constructed with advanced composites and metallic materials, combined to promote ballistic capabilities and reduce weight. The hull/turret will be designed to reduce the overall signature by utilization of stealthy materials and design contours. Survivability will be enhanced through the use of an advanced add-on modular armor kit which can be installed by the crew before entering combat. Crew survivability will be enhanced by having them encased deep inside the hull.

The FCS will be equipped with an all-around day/night 360-degree array of television/thermal cameras and computer processed vision, which will enable the crew to see through the fog of battle.

The FCS will be equipped with a signature management system that will manage radar, acoustic, visual, thermal/infrared and magnetic emissions. In addition, the FCS will be equipped with a counter-measurers suite, which can generate false target images, and passive and active decoys, which can divert incoming homing missiles.

The FCS will be equipped with a self-defense hit-avoidance suit, which would automatically detect, prioritize, counter and intercept enemy missiles, helicopters, vehicles, high performance aircraft, top-attack anti-tank munitions and other anti-tank threats.

The FCS will be equipped with an automatic detection, alert, avoidance and protection system for areas contaminated by weapons of mass destruction. The FCS will also be equipped with a passive/active mine detection, avoidance and destruction system that will work while the vehicle is on the move.

Multi-net communications: The FCS will be equipped with voice, data and imagery communications systems that can operate on multiple channels to collect, send, receive, and integrate information from a variety of sources.

Deployability: Reduced weight and lower silhouette will enable the FCS to be transported in C-130 like aircraft. Once in the combat zone, the crew can install the advanced add-on modular armor kit to enhance survivability.

Mobility and agility: The FCS will be powered by a hybrid electric power system. This system would provide the capability for generation and storage of electricity. The FCS will be driven by an all-electric power train that will provide between 800 and 1,200 HP. The power train will propel the FCS at 100 kilometers per hour cross-country and provide the energy to drive the EM gun and high-energy laser gun. The FCS will have a computerized hydropneumatic suspension that will provide a smooth ride at high cross-country speeds.

Sustainability: The all-electric power system will be driven by the power train and/or alternate energy sources, such as solar collectors, to minimize the dependence of conventional fuels.

The EM and high-energy laser guns will significantly reduce reliance on resupply of conventional ammunition. The FCS platform will have embedded diagnostics, prognostics, and repair capabilities to reduce the supply chain and sustainment tasks and time. Major system and component design will consider ease of maintenance, self-repair, self-recovery, and aerial resupply. In addition, all components will incorporate plug-in replacement that requires no special equipment and minimal common tools.[73]

This envisioned FCS meets all the capabilities specified by the Army. In addition, it provides a platform to meet the strategic needs of the joint force commander. The actual configuration is not as important as the features incorporated in its design concept. Design and development of FCS is a high-risk venture that is highly dependent on the science and technology community to provide these capabilities to support EMD decisions by FY 2006. What the future will bring depends in part on what we ask of it.

CONCLUSIONS

Tank development since World War II has been based on Cold War threats, an evolution driven by one-upsmanship and steady advances in technology. Global and political changes since the end of the Cold War now required the Army to transform its armored forces.

Transformation of the Army's armored forces will be evolutionary in that the processes of change are very much the same as those used since the end of World War II. However, the ultimate transformation will be revolutionary for it will create an armored force that is versatile, agile, and lethal, capable of meeting the full spectrum of future battlefield challenges. This force will be radically different from the heavy armored force designed to counter the Soviet threat on the central plains of Europe.

General Shinseki's timelines for Army transformation are based on equipping the IBCT with a "off-the-shelf" family of armored fighting vehicles. This has not happened. The acquisition of the LAV 3 family of vehicles has been delayed by the inability of GDLS/GM to meet the Army's production schedule; by filing of a contract protest by United Defense L.P.; and by the inability of GDLS/GM to provide three of ten LAV 3 variants until the FY 2004 to FY 2006 time frame. These delays will significantly impact the development of doctrine, training of personnel, and mission capabilities of the IBCT.

History has provided us with many examples of problems caused by implementing technologies before they have been thoroughly tested. We should anticipate that all desired technologies to be incorporated into the FCS will not be available to support EMD decisions by

FY 2006. We should implement only those technologies which are mature on a platform which is designed to accept future capabilities as they become available.

> America has some big choices to make as we prepare for the challenges and dangers of modern warfare. Battles will no longer be won by size alone – stealth and speed will matter more.
>
> —President George W. Bush

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